

BOYLE'S LAW

Name _____

Boyle's Law states that the volume of a gas varies inversely with its pressure if temperature is held constant. (If one goes up, the other goes down.) We use the formula:

$$P_1 \times V_1 = P_2 \times V_2$$

Solve the following problems (assuming constant temperature).

1. A sample of oxygen gas occupies a volume of 250. mL at 740. torr pressure. What volume will it occupy at 800. torr pressure?

2. A sample of carbon dioxide occupies a volume of 3.50 liters at 125 kPa pressure. What pressure would the gas exert if the volume was decreased to 2.00 liters?

3. A 2.0 liter container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.0 atm?

4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?

5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?

6. A sample of hydrogen at 1.5 atm had its pressure decreased to 0.50 atm producing a new volume of 750 mL. What was its original volume?

7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?

8. Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm, its volume is 250. mL. What was the original volume?

CHARLES' LAW

Name _____

Charles' Law states that the volume of a gas varies directly with the Kelvin temperature, assuming that pressure is constant. We use the following formulas:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad V_1 \times T_2 = V_2 \times T_1$$

$$K = ^\circ C + 273$$

Solve the following problems assuming a constant pressure.

1. A sample of nitrogen occupies a volume of 250 mL at 25° C. What volume will it occupy at 95° C?

2. Oxygen gas is at a temperature of 40° C when it occupies a volume of 2.3 liters. To what temperature should it be raised to occupy a volume of 6.5 liters?

3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?

4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?

5. A sample of neon gas at 50° C and a volume of 2.5 liters is cooled to 25° C. What is the new volume?

6. Fluorine gas at 300 K occupies a volume of 500 mL. To what temperature should it be lowered to bring the volume to 300 mL?

7. Helium occupies a volume of 3.8 liters at -45° C. What volume will it occupy at 45° C?

8. A sample of argon gas is cooled and its volume went from 380 mL to 250 mL. If its final temperature was -55° C, what was its original temperature?

COMBINED GAS LAW

Name _____

In practical terms, it is often difficult to hold any of the variables constant. When there is a change in pressure, volume and temperature, the combined gas law is used.

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2} \quad \text{or} \quad P_1 V_1 T_2 = P_2 V_2 T_1$$

Complete the following chart.

	P_1	V_1	T_1	P_2	V_2	T_2
1	1.5 atm	3.0 L	20° C	2.5 atm		30° C
2	720 torr	256 mL	25° C		250 mL	50° C
3	600 mmHg	2.5 L	22° C	760 mmHg	1.8 L	
4		750 mL	0.0° C	2.0 atm	500 mL	25° C
5	95 kPa	4.0 L		101 kPa	6.0 L	471 K or 198° C
6	650. torr		100° C	900. torr	225 mL	150° C
7	850 mmHg	1.5 L	15° C		2.5 L	30° C
8	125 kPa	125 mL		100 kPa	100 mL	75° C

DALTON'S LAW OF PARTIAL PRESSURES

Name _____

Dalton's Law says that the sum of the individual pressures of all the gases that make up a mixture is equal to the total pressure or : $P_T = P_1 + P_2 + P_3 + \dots$ The partial pressure of each gas is equal to the mole fraction of each gas x total pressure.

$$P_T = P_1 + P_2 + P_3 + \dots \quad \text{or} \quad \frac{\text{moles gas}_x}{\text{total moles}} \times P_T = P_x$$

Solve the following problems.

1. A 250. mL sample of oxygen is collected over water at 25° C and 760.0 torr pressure. What is the pressure of the dry gas alone? (Vapor pressure of water at 25° C = 23.8 torr)

2. A 32.0 mL sample of hydrogen is collected over water at 20° C and 750.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 20° C = 17.5 torr)

3. A 54.0 mL sample of oxygen is collected over water at 23° C and 770.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 23° C = 21.1 torr)

4. A mixture of 2.00 moles of H_2 , 3.00 moles of NH_3 , 4.00 moles of CO_2 and 5.00 moles of N_2 exerts a total pressure of 800 torr. What is the partial pressure of each gas?

5. The partial pressure of F_2 in a mixture of gases where the total pressure is 1.00 atm is 300. torr. What is the mole fraction of F_2 ?

Match each example below with the appropriate gas property it illustrates.

Ch 10 Review

Problems

Example

1. A bicycle tire inflates when you pump air into a valve on one side.
2. A car is supported on a "cushion of air."
3. An air mattress springs back to its original shape after being pressed.
4. A balloon filled with air weighs more than an empty balloon.
5. The color of a gas is uniform throughout the bottle containing it.

Gas Property

- a. compressibility
- b. has mass
- c. fills container
- d. exerts pressure
- e. diffuses through other gases

If the statement is true, write "true." If it is false, change the underlined word or words to make the statement true.

6. Although air is a mixture of several gases, it behaves like a single gas.
7. Oxygen is diatomic, and, under similar conditions, its volume is twice that of monatomic helium.
8. Air bags are used as safety devices in cars because air cannot be compressed.
9. Most gases are made up of single atoms.
10. According to the kinetic-molecular theory, the collisions between gas particles are 100 percent elastic.
11. The pressure of a gas is simply a measure of the kinetic energy of the gas particles.
12. The volume of a gas is equal to the volume of its container.

Indicate the relationship between the pairs of gas variables below by writing "increase," "decrease," or "not be affected" in the space provided. Assume that all other variables remain constant.

13. If the molecular speed of a gas increases, its rate of diffusion will _____.
14. If the temperature of a gas increases, the pressure of the gas will _____.
15. If the molecular weight of a gas increases, the total volume of the gas will _____.
16. If the temperature of a gas decreases, the pressure of the gas will _____.

8 The cylinder of a car's engine has a volume of 0.6250 L when the piston is at the bottom of the cylinder. When the piston is at the top of the cylinder the volume is 0.0600 L. If the cylinder is filled with air at an atmospheric pressure of 765.1 mm Hg when the piston is at the bottom, what is the pressure in units of kPa when the piston is at the top of the cylinder?

9 What is the pressure of a mixture of helium, nitrogen, and oxygen if their partial pressures are 600. mm Hg, 150. mm Hg, and 102 mm Hg?

10 A flask contains a mixture of hydrogen and oxygen. The pressure being exerted by these gases is 785 mm Hg, as determined by a manometer. If the partial pressure of the hydrogen in the mixture is 395 mm Hg, what is the partial pressure of the oxygen?

11 The barometer shows the atmospheric pressure to be 762 mm Hg. What is the partial pressure of nitrogen if nitrogen makes up 78 percent of the air?

12 What partial pressure of oxygen is a scuba diver breathing if the total pressure is 6.3 atm, and 20. percent of the air is oxygen?

13 What is the atmospheric pressure if the partial pressures of nitrogen, oxygen, and argon are 77.75 kPa, 19.94 kPa, and 1.99 kPa, respectively?

14 The partial pressure of water vapor in a greenhouse is 139.0 mm Hg, which is 18 percent of the total pressure. What is the total pressure in the greenhouse?

1 The air pressure for a certain tire is 109 kPa. What is this pressure in atmospheres?

2 The weather news gives the atmospheric pressure as 1.07 atm. What is this atmospheric pressure in mm Hg?

3 An experiment at Sandia National Labs in New Mexico is performed at an atmospheric pressure of 758.7 mm Hg. What is this pressure in atm?

4 A bag of potato chips is sealed in a factory near sea level. The atmospheric pressure at the factory is 761.3 mm Hg. The pressure inside the bag is the same. What is the pressure inside the bag of potato chips in Pa?

5 What will be the volume of a gas sample at 309 K if its volume at 215 K is 3.42 L? Assume that pressure is constant.

6 A tank of compressed CO₂ has a temperature of 23.6°C and a volume of 31.4 L. The CO₂ is completely transferred into a smaller tank that has a volume of 25.0 L. Assuming none of the CO₂ escapes during the transfer, what is the temperature of the CO₂ in the smaller tank if the temperature is lowered to achieve the same pressure as in the larger tank?

7 A gas occupies a volume of 2.45 L at a pressure of 1.03 atm and a temperature of 293 K. What volume will the gas occupy if the pressure changes to 0.980 atm and the temperature remains unchanged?

